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OCEANOGRAPHY.—*On the temperature of the water below the 500-fathom line on the west coast of South and North America.*[1] AUSTIN H. CLARK, National Museum.

A critical examination of the temperature observations taken by the *Albatross* in water of over 1000 fathoms in depth between California and the Hawaiian Islands[2] appears to indicate that in the oceanic abysses of the north Pacific there is a distinct, though slight, rise in temperature along this line from east to west.

A similar study has been made of all the *Albatross* records for temperatures below 500 fathoms, 417 in number, from Chile to and including the Bering Sea. The most striking feature of the abyssal temperatures of the eastern Pacific is the very small range of maximum variation (see last column of table), which is much less than in the east Atlantic.

For water of over 2000 fathoms in depth we have no records south of Mexico; on the southern coast of Mexico the water below the 2000-fathom line is +0.65° (that is, 0.65° above the average temperature for the whole ocean at that depth as given by Murray and Hjort); off central Mexico it is slightly cooler, +0.17°; off northern Mexico there is almost the same drop, to −0.30°; the next reading, roughly between the Columbia River and southern Alaska, is warmer again, −0.09°, while in the Gulf of Alaska the temperature is nearly intermediate between that off northern Mexico and that off the northwestern

[1] Published with the permission of the Commissioner of Fisheries.

[2] Journ. Wash. Acad. Sci., 6: 175–177. 1916.

United States and British Columbia, −0.21°; in Bering Sea, where depths greater than 2000 fathoms occur only in the western part, the temperatures below 2000 fathoms are intermediate between those off the northwestern United States and British Columbia and those in the Gulf of Alaska, −0.15°.

The temperatures between 1500 and 2000 fathoms show a maximum of +0.80° off northern South America and southern

TABLE I

DEPTH (FATHOMS)	500–750	750–1000	1000–1500	1500–2000	OVER 2000
Off Chile (45° 35′ to 38° 08′ S.)	**−0.20** (1)	—	+0.40 (3)	—	—
Galápagos Islands	+1.30 (4)	+0.93 (3)	+0.62 (4)	—	—
South and Central America to Mexico	+0.98 (9)	+1.22 (8)	+0.66 (17)	+0.80 (19)	—
West coast of Mexico to 16° 46′ N.	+0.92 (4)	+0.75 (2)	—	+0.66 (3)	+0.65 (2)
Mexico; 18° 23′ N. to the Gulf of California	+0.75 (6)	+0.80 (2)	+0.25 (2)	+0.13 (14)	+0.17 (9)
Gulf of California	+1.10 (1)	+0.50 (3)	+1.40 (3)	+1.10 (1)	—
Gulf of California to 32° N.	+0.50 (3)	+0.42 (4)	**−0.04** (5)	**−0.10** (4)	**−0.30** (5)
California; 32° to 33° 42′ N.	+0.22 (16)	+1.51 (12)	+0.70 (1)	—	—
33° 42′ to 45° N.	**−0.40** (13)	+0.38 (5)	—	—	—
45° to 55° N.	**−0.97** (17)	**−0.46** (16)	**−0.36** (8)	**−0.03** (12)	**−0.09** (10)
55° to 59° 19′ N.	**−1.72** (8)	**−0.85** (8)	**−0.37** (7)	**−0.09** (20)	**−0.21** (20)
Bering Sea	**−1.71** (20)	**−0.91** (12)	**−0.69** (25)	**−0.23** (20)	**−0.15** (26)
Maximum range in Temperature	3°.27	2°.36	2°.09	1°.33	0°.95

Central America, and a second more strongly marked maximum of +1.10° in the pocket-like Gulf of California. North of the Gulf of California the readings are all below normal, varying from −0.03° between 45° and 55° N. lat. to −0.23° in the Bering Sea. It is interesting that the temperature off northern Mexico and the southwestern United States (−0.10°) is approximately identical with that from 55° to 59° N. lat. (−0.09°), though the two localities are separated by a region showing a deficiency only one third as great (−0.03°).

The temperatures between 1500 and 2000 fathoms correspond closely with those below 2000 fathoms; but while south of the Gulf of California the excess is the same for both levels, north of that point the deficiency in the shallower water is approximately only one third of what it is in the deeper, excepting in the Bering Sea, where it is half again as great.

The series of temperatures between 1000 and 1500 fathoms is interesting in showing an excess of warmth off the Chilean coast (+0.40°) increasing to off northern South and Central America (+0.66°), where we noted the maximum in the preceding series, and decreasing again off central Mexico (+0.25°), as in the 1500–2000 fathom level. In the Gulf of California there is, as before, a second, higher, maximum (+1.40°). Off southern California there is apparently a considerable excess, but this is based on a single record which is very likely erroneous. Except for this the deficiency increases from the region north of the Gulf of California (−0.04°) to the Gulf of Alaska (−0.37°), becoming nearly twice as great again (−0.69°) in the Bering Sea.

The points of especial interest are the maximum off northern South and Central America, and the uniformity between 45° and 59° 19′ N. lat., the latter contrasting with what we found to be the case at the two preceding levels.

Between 750 and 1000 fathoms the points of interest are: (1) A well marked maximum (+1.22°) off northern South and Central America; (2) a relatively low excess (+0.50°) in the Gulf of California, which is continued to 32° N.; and (3) an excess, instead of a deficiency as everywhere below 1000 fathoms, as far as 33° 42′ N.

Between 500 and 750 fathoms the chief excess is in the Galápagos Islands (+1.30°) and in the Gulf of California (+1.10°). There is a deficiency off Chile, and a progressively increasing deficiency from 33° 42′ N. to the Gulf of Alaska and the Bering Sea.

If we except for the moment the pocket-like Gulf of California, which is comparable to the Red Sea or the Adriatic, the abyssal temperatures along the west American coast are found to fall into two classes, one capable of further subdivision, as follows:

(1) Temperatures all above the average (*South and Central America to the Gulf of California*)

(2) Temperatures all below the average (*southern California and northward to and including the Bering Sea*)

(*a*) Temperatures considerably below normal (*southern California and the Gulf of Alaska*)

(*b*) Temperatures slightly below normal (*central California to Alaska*)

(*c*) Temperatures intermediate (*Bering Sea*)

The regularity in the rise in the temperature of the abyssal water from Chile to the Panamic region and the subsequent drop in temperature along the Mexican coast suggests that the temperature of the deep water in the vicinity of the coast is influenced by the volume of warm water delivered in the region of Panama and southern Central America by the Equatorial Counter Current which, unable to extend to the northward because of the strong California Current which acts as a barrier, is exerted to the southward along the South American coast, within the region dominated by the Humbolt Current.

There is no need in this connection for assuming any extensive flow of water southward along the South American coast, for a relatively slight amount of water delivered in the upper layers on the northwestern South American coast would suffice to depress the isotherms sufficiently to give the figures observed.

The Gulf of Alaska is essentially a backwater or cul-de-sac, and the marked coldness of its abysses appears to indicate that this condition extends to its greatest depths; that is to say, that the coldness of its abysses is due to local causes, chiefly the chilling of its upper layers in winter. It is probably this chilled water from the Gulf of Alaska moving southward which causes the deficiency in the temperature of the deeper levels (as well as of the upper layers), all the way to the region just north of the Gulf of California.

It would appear that the water off southern California in the well known region of up-welling is colder than in the region between southern California and the Gulf of Alaska. There is no reason why this should be so unless the cold water along

this coast is supplied, as I have already suggested (basing my conclusions on biological data) may be the case, from the Antarctic regions through the medium of an offshore abyssal current which is drawn shoreward by the upwelling off southern California and in the Gulf of Alaska. But the observations on the bottom temperatures between California and the Hawaiian Islands seem to cast serious doubt on the existence of such a current. The biological data are adequate, and point to a definite conclusion; but since animals readily pass from water of a certain origin to water of quite a different origin, if the two have the same biological coefficient (temperature, food value, salinity, and silt in approximately the same relative proportions), biological data are always unreliable. The physical data are far from exact, and we have no chemical data. Thus the true explanation of this phenomenon, if it be real and not merely the result of inaccurate thermometer readings, must be left to the future.

In the Bering Sea there are 103 temperature observations in water of over 500 fathoms in depth which may be regarded as approximately accurate.

Between 500 and 750 fathoms the average temperature for the Bering Sea as a whole is $-1.71°$ below that of the entire ocean. There is an appreciable, though small, difference between the regions east and west of the 180th meridian, the former being 0.63° warmer than the latter. But below 750 fathoms there is no appreciable difference east and west of 180°—only 0.02° between 750 and 1000 fathoms, with the lower reading in the east, and 0.01° from 1500 to the deepest readings, with the lower reading in the west.

Between 750 and 1000 fathoms we find an average temperature $-0.91°$ below that of the ocean as a whole at that depth; between 1000 and 1500 an average of $-0.69°$; between 1500 and 2000 an average of $-0.23°$; and below 2000 an average of $-0.15°$. This is in interesting contrast to the conditions in the Gulf of Alaska where the temperature of the water is approximately the same as in the Bering Sea as a whole between 500 and 1000 fathoms, less cold between 1000 and 2000 fathoms, more cold again below 2000 fathoms.

PHYSICS.—*Constants of spectral radiation of a uniformly heated inclosure or so-called black body, II.*[1] W. W. COBLENTZ, Bureau of Standards.

A knowledge of the exact value of the constants which enter into the mathematical equation which represents the distribution of energy in the spectrum of a black body is necessary in many physical problems, especially in extending the temperature scale higher than is possible by means of thermocouples.

Spectral energy curves have been obtained by means of a vacuum bolometer, a mirror spectrometer, and a fluorite prism; and the constants of spectral radiation of a black body have been published in a previous paper.[2]

The present paper gives the result of a recomputation of these constants. This recomputation was necessitated by the adoption of a new and apparently more reliable calibration curve of the fluorite prism used in the work, and by the discovery of a small error which was found in the previous computations. Although these errors are small (and would have been considered negligible four years ago) they happen to be of the same sign and, hence, have an appreciable effect upon the final result.

The results of the present computations give a mean value of $C = 14369$, which is close to the mean value of all the published data.

When the data of other investigators are summarized, it is found that they lie close to $C = 14350$.

From a consideration of the data now available it appears that the values of the constants of spectral radiation are close to

$$C = 14350 \text{ micron deg.}$$
$$A = 2890 \text{ micron deg.}$$

and that the coefficient of total radiation is of the order of $\sigma = 5.7 \times 10^{-12}$ watt cm.$^{-2}$ deg.$^{-4}$. This indicates that the constant h of the quantum theory is of the order $h = 6.56$ to 6.57×10^{-27} erg sec.

[1] Detailed paper to appear as Bur. Stds. Sci. Paper No. 284 (Bull. Bur. Stds., **13**: 459–477). 1916.

[2] Bur. Stds. Sci. Paper No. 204 (Bull. Bur. Stds., **10**: 1–77). 1913.

PHYSICS.—*A study of the inductance of four-terminal resistance standards.*[1] FRANCIS B. SILSBEE, Bureau of Standards.

The precise measurement of alternating currents frequently involves the use of standard resistances, the inductance of which should be known. When the currents are large the standards used are usually of low resistance, and a very small inductance in such a standard may produce a very considerable phase angle between the voltage drop across the resistance, and the current. In the range below one ohm the resistances are almost invariably of the four-terminal type and, therefore, require methods of measurement which are quite distinct from those applicable to higher resistances. The object of this investigation was to develop methods for comparing the phase angles of such four-terminal resistances and also to construct standards, having a very small known inductance, with which other apparatus could be compared.

If we consider a four-terminal resistance (or more briefly a "shunt") which carries a sinusoidal alternating current, we will find that the voltage between the potential terminals is not, in general, in phase with the current, but may be resolved into two components, one in phase and one in quadrature. The resistance of the shunt is defined as the ratio of the in-phase component of the voltage to the current, while the reactance is the ratio of the quadrature component of the voltage to the current. The angle whose tangent is the ratio of the reactance to the resistance is the phase angle of the shunt. The inductance is, of course, equal to the reactance divided by 2π times the frequency; the time-constant is the ratio of the inductance to the resistance. This latter quantity is very nearly constant over the range of commercial frequencies and is a measure of the amount by which a shunt departs from the ideal condition of giving a voltage exactly in phase with the current.

In some of the measurements described below it was necessary to use mutual inductances, and it was found that these

[1] Detailed paper to appear as Bur. Stds. Sci. Paper No. 281 (Bull. Bur. Stds., 13:375–422). 1916.

did not in general satisfy the ideal condition of giving a secondary voltage in exact quadrature with the primary current but that the voltage had a small in-phase component. By analogy with the case of the shunt we may define the "resistance" of the mutual inductance as the ratio of this in-phase component of the voltage to the primary current. We will further define the "phase defect" as the angle whose tangent is the ratio of the in-phase component of the voltage to the quadrature component.

The method which was found most suitable for the comparison of the time-constants of two shunts may be called the *current transformer method.* It consists essentially in measuring the apparent phase angle of a current transformer by one of the usual null methods, using in succession, as the standard resistance in the primary circuit of the transformer, the two shunts to be compared. The apparent change in the phase angle of the transformer is the difference in the phase angle of the two shunts. A group of about twenty shunts were intercompared by this method and form a basis for future comparisons. A second method involving the use of mutual inductances was tried out, and gave results in agreement with the first method, but was found to be much less convenient.

Since the comparison methods just mentioned give only the difference in time constants of two four-terminal standards, some other measurement is needed to give the actual value of the time-constant of one four-terminal shunt in terms of known quantities. The simplest way to obtain this value is to construct a shunt of such shape that its inductance can be computed from its measured dimensions. This procedure requires that certain assumptions be made as to current distribution, etc.; a careful investigation using three different shapes of shunt showed that the assumptions made are completely justified. As a check, two other methods of measurement were tried; one involved the use of mutual inductances of known phase defect, and the other made use of two shunts constructed of identical dimensions but of materials of different resistivities. These methods gave results in agreement with the computed values, but were less accurate and more laborious. It is believed that the time con-

stants of this group of 20 shunts (ranging from 0.1 ohm to 0.00025 ohm) at the Bureau of Standards are known to an accuracy of 1 or 2 $\times 10^{-7}$ second. With a frequency of 60 cycles and an uncertainty of 2 $\times 10^{-7}$ second in the time-constant the phase angle between the voltage and current is uncertain by about 15 seconds of arc.

Further measurements were made on other types of shunt and also on the effect of stray magnetic fields on the apparent time-constants of the shunts.

In the design of shunts for use with alternating currents it appears that the liability to error can be minimized by so locating the potential leads that the inductive effects in them completely neutralize the inductance of the resistance material itself so that the shunt as a whole is strictly non-inductive. The type in which the resistance material forms one or both of two concentric tubes lends itself very readily to this form of compensation.

A study of the phase defects of mutual inductances of large current capacity showed that this source of error was by no means negligible and that it was particularly large in cases where the secondary was wound in several layers. Errors from this source can be minimized by making one of the windings, preferably the secondary, in the form of a uniformly wound closed toroid of fine wire, in which case the other winding may be of large cross-section.

CHEMISTRY.—*The determination of aluminium as oxide.*[1] WILLIAM BLUM, Bureau of Standards.

From observations made with a hydrogen electrode and with suitable indicators, it has been found that the precipitation of aluminium hydroxide by ammonium hydroxide is complete when $[H^+] = 10^{-6.5}$ to $10^{-7.5}$—points which are approximately defined by the color changes of methyl red and of rosolic acid. From a study of the various factors, the following conditions are recommended for the determination of aluminium. To

[1] To appear in detail as Bur. Stds. Sci. Paper No. 286 (Bull. Bur. Stds., vol. 13). 1916.

the solution containing 5 grams of ammonium chloride per 200 cc. of solution (or an equivalent amount of hydrochloric acid) add a few drops of methyl red (0.2 per cent alcoholic solution) and heat the solution just to boiling. Carefully add dilute ammonium hydroxide, dropwise, till the color of the solution changes to a distinct yellow. Boil the solution for one or two minutes; filter. Wash the precipitate thoroughly with hot 2 per cent ammonium chloride, or nitrate, solution. Ignite in a platinum crucible and, after the carbon is all burned off, blast for five minutes; cover the crucible and place it in a desiccator till cool. Weigh (covered) as rapidly as possible. A second blasting of five minutes is desirable to facilitate rapid weighing, and thus to secure what are probably more accurate results.

PALEONTOLOGY.—*Oligocene fossil eggs.* EDWARD L. TROXELL, Ann Arbor, Michigan. (Communicated by H. H. Bartlett.)

Fossil remains of birds are rare. It is of unusual interest therefore to note the finding of two fossil eggs from the Oligocene bad-lands near Harrison, Nebraska. The specimens, which are elongated and slightly smaller at one end, resemble both in size and shape those of the domesticated chicken or of the Mallard duck. The very rugose outer surface, not found on the eggs of most modern birds, is, however, characteristic of those of the gull, and it is entirely in harmony with the theory of their deposition that they should have been laid by a water fowl. The shell, which measures about 0.6 mm. in thickness, still retains its calcium phosphate, the only part of the specimen which we can say definitely is a remnant of the original. (This chemical test is due to the courtesy of Mr. R. W. Clark of the Mineralogy Department of the University of Michigan.)

The first of the two specimens above mentioned was found by Mr. Vernon Marsteller, of Wayne College, who was a member of my party in 1915. Fossil eggs are mentioned in the South Dakota Geological Survey Report, Bulletin 9, by C. C. O'Harra, and one is fully described by O. C. Farrington in Publication 35 of the Field Columbian Museum, 1899.

FIRST SPECIMEN

The first specimen (length 59 mm., diameter 43 mm.) has the shell intact except at a few spots where it has been eroded away. Immediately beneath the shell is a layer of chalcedony about 2 mm. thick, continuous, though slightly irregular on its inner surface. The first half shows no banding but is a homogenous layer of transparent material deposited from the colloidal silica within, while the inner half, resulting from an intermittent or periodic deposition which soon ceased, shows the banding peculiar to agate.

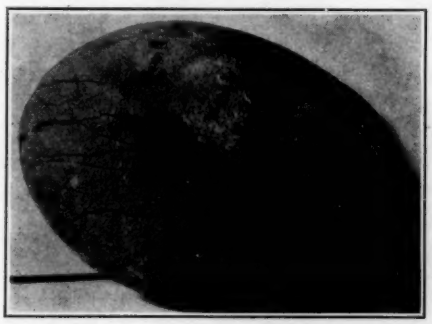

Fig. 1. Fossil egg, first specimen. Exterior view, about natural size.

Within, the egg is filled with calcite, except for a small siliceous geode at one end; thus the calcite was formed after the outer layer of agate was in place. The diverse lines of cleavage show that the calcite is not a single crystal, although it now fills the cavity completely.

There must have been a hollow in the calcite at the smaller end of the egg which is now occupied by the irregular mass of chalcedony, for the outer surface of the latter, with its flat faces, sharp angles, and irregular striations, indicates that it came after and fashioned itself to the

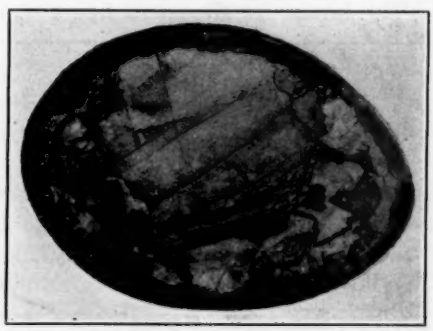

Fig. 2. Same, sawed in two and polished. About natural size. Note the band of agate next to the shell, the chalcedony geode at the smaller end, and the cleavage planes of the calcite crystals.

surfaces of the calcite crystals. On the other hand the space within the calcite may have been left when the growth of the crystals had reached its limit, or it may have been occupied by the desiccated residue of the egg material. The inner surface of the geode is lined with minute crystals of quartz.

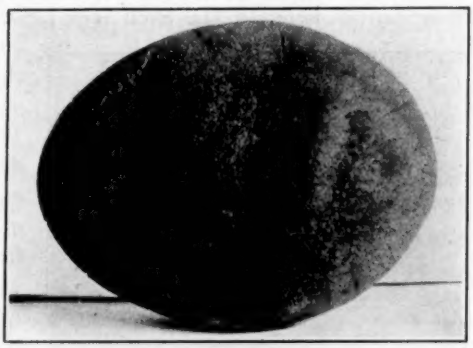

Fig. 3. Fossil egg, second specimen. Top view, about natural size. The very rough surface is unlike that of most modern eggs. The cracks in the edge as well as the change in form indicate the extensive crushing.

SECOND SPECIMEN

The second specimen of fossil egg was flattened to about three fourths its former diameter; because of this distortion and because of the total absence of silica it presents some added points of interest. The dimensions are: Length 61 mm., width 48 mm., thickness 34 mm.

The hump, as shown in figure 4, appears to be a result of rigid opposition in the center while the edges were forced down. In reality it is simply the normal arch displaced. There was pliable resistance within the egg; the strain, therefore, which shortened the vertical diameter resulted in an increase in the horizontal dimensions; quite probably the volume did not change appreciably. Except for this there would have been real crushing or caving in without a corresponding increase in size laterally.

Fig. 4. Side view of specimen shown in figure 3. About natural size.

The flattening and consequent increase in circumference caused a series of perpendicular cracks around the edge, just such as might be formed by flattening a mud ball. Although fracturing occurred, the pressure within was sufficient to prevent the entrance of clay or other solid material. It is quite probable, therefore, that the egg was fresh when buried and that the surrounding mud, after settling, solidified before the removal of the animal matter and before the deposition of calcite began.

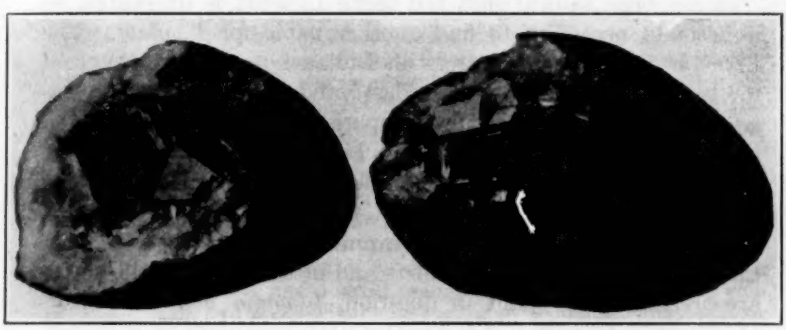

Fig. 5. Same as figures 3 and 4, showing the crystalline interior. About natural size. The large amber crystal of calcite in the center seems to have taken the place of the yolk, while the white crystals surround it. This similarity is only an interesting coincidence, for the parts, except the shell, bear no relation to the original egg.

Calcite is the only mineral occupying the cavity of this specimen; beneath the shell there is a 5 mm. layer made up of small crystals and within this, occupying the center but not entirely filling it, is a large double crystal of amber hue. One is struck at once with the great similarity in appearance to a modern egg in which are found the shell, white, and yolk in the same position and relative proportions. It is an unusual case of mimicry on the part of inanimate nature, for it is incredible that the soft part of an egg should exert such an influence on crystallizing calcite as to impose its form and color.

BOTANY.—*Pleiospermium, a new genus related to Citrus, from India, Ceylon and Java.* WALTER T. SWINGLE, Bureau of Plant Industry.

In 1834 Wight and Arnott described[1] as a new species *Limonia alata*, putting it with *Limonia missionis* in a section *Limoniae spuriae*, in contrast to *Limonia acidissima*, which constituted a section *Limoniae verae*. All subsequent authors have retained it in the genus Limonia.

It has been shown[2] that the name Limonia is untenable, so it becomes necessary to find another name for *L. alata*. The *Limonia acidissima* of writers on Indian botany is the type of the genus Hesperethusa, the oldest valid name being *H. crenulata* (Roxb.) Roem.; but a comparison of these two plants, both formerly put in the genus Limonia, has convinced the writer that they are not congeneric. The genus Hesperethusa has minute black fruits, usually 4-celled, with only a single seed in each cell; the leaves are pinnate, with a broadly alate rachis; the margins of the leaflets and of the wings of the rachis are crenate. The plant in question, *Limonia alata*, has fruits about an inch in diameter, usually with two seeds in each cell, the seeds surrounded by a glutinous fluid. The leaves are usually trifoliolate and the leaflets are entire.

These differences are of much taxonomic significance in this group of plants and in consequence it seems necessary to create a new genus to include *Limonia alata* and its little-known congener, *L. dubia* Blume.

In 1896 Engler created under the genus Limonia a new section, Pleiospermium,[3] with a single species, *Limonia alata*. This being the oldest name for the group, it may be retained as the generic designation.[4]

[1] WIGHT & ARNOTT. Prodr., **1**: 92. 1834.

[2] SWINGLE, WALTER T. *The name of the wood-apple, Feronia Limonia.* Journ. Wash. Acad. Sci., **4**: 325–328. 1914.

[3] ENGLER & PRANTL. Nat. Pflanzenfam., **3**[4]: 189. 1896.

[4] **Pleiospermium** Swingle, gen. nov. (Limonia §Pleiospermium Engl.). Genus *Pamburo* affine, foliis 3-foliolatis (vel 1–2-foliolatis), tenuibus, venis conspicuis, disco parvo, parietibus ovarii vesiculis brevibus instructis.

Folia 3-foliolata vel 2-foliolata vel 1-foliolata, petiolis plus minusve alatis,

Pleiospermium (Engler) Swingle, gen. nov.

Small trees with glabrous branchlets, sometimes with a single stout spine (or two spines) at the side of the bud in the axil of the leaf, sometimes spineless, especially the fruiting branches. Leaves typically trifoliolate with the lateral leaflets much smaller than the terminal one, sometimes bifoliolate or unifoliolate (very often so in *P. dubium*), of medium thickness, glossy above, finely netted-veined beneath; lateral veins slender, not very conspicuous, making a very obtuse angle with the midrib; margin entire, the apex obtuse or subacute, rarely acuminate, bluntly rounded at the very tip, the leaflet blade abruptly narrowed to a cuneate base; petiole variable in length, narrowly winged (in *P. dubium* sometimes nearly apterous), articulated with the blade. Flowers small, about 12 to 15 mm. in diameter, 4–5-merous, borne on rather short, finely pubescent pedicels, in clusters in the axils of the leaves or in a terminal much-branched hoary panicle. Flower buds cylindric, rounded at the tip, more or less pubescent; calyx small, 4–5-lobed; sepals deltoid, finely pubescent. Petals oblong or ovate, obtuse, entire, sparingly covered with fine pubescence on the outer surface. Stamens free, 8 or 10 (twice as many as the petals); filaments free; anthers large, erect, linear-oblong or oblong. Pistil subsessile, seated on a low annular disk; style slender, gradually merging with the tip of the ovary, ending in the somewhat thicker capitate stigma; ovary ovate, 4- or 5-celled, with 2 ovules in each cell. Fruits globose, like a small orange in appearance, the cells containing one or two seeds surrounded with an aromatic, mucilaginous fluid, and, at least in *P. dubia*, having short, slender pulp vesicles scattered on the inner ovary wall. Peel rough, dotted with numerous oil glands. Seeds oval, flattened; germination unknown.

Type species, **P. alatum** (*Limonia alata* Wight & Arn.), native to southern India and Ceylon.

GEOGRAPHIC RANGE: India, Ceylon, Java, and adjacent islands (?).

The genus Pleiospermium is most closely related to Pamburus and Merope, having soft-rinded fruits resembling very small oranges or lemons in appearance but having only 4 or 5 cells, filled with a glutinous fluid, each cell containing 1 or 2 seeds. All three of these genera are

laminis articulatis; laminae tenues superne nitidae subtus reticulatae. Spinae rectae axillares solitariae vel binae vel carentes. Inflorescentiae pubescentes, 5–15-florae; flores mediocres, 4- vel 5-merae; petala alba oblonga; stamina libera, 8 vel 10, filamentis tenuibus; stylus tenuis, ovario paulo longior; stigma capitatum diametro stylo paulo majus; ovarium 4–5-loculare, ovulis in loculo binis. Fructus parvus, subglobosus, cortice ut in *Citro* carnosa, parietibus ovarii vesiculis brevibus instructis, loculis 1–2-spermis, liquore glutinoso aromatico repletis. Semina complanata, ovalia.

Arbusculae ramosae spinosae vel inermes, ramulis junioribus tenuibus plus minusve angulosis. Species typica, **Pleiospermium alatum** (*Limonia alata* Wight & Arn.). Habitat in India, Zeylona, et Java.

small spiny trees. Paramignya and Lavanga have similar fruits, but are woody lianes with recurved spines and aberrant leaf characters. The genus Pleiospermium differs from Pamburus in having thinner, netted-veined, usually trifoliolate leaves, with the lamina articulated with the petiole, instead of thick, nearly veinless, unifoliolate leaves and the lamina not articulated with the petiole; furthermore, Pleiospermium has the ovary seated on a small annular disk, while in Pamburus the disk is prominent and cylindric. The flower, fruit, and seed characters of Pleiospermium are very different from those of Merope. Pleiospermium is only rather remotely related to Hesperethusa, Triphasia, and Severinia, which all have very small red or black berry-like fruits and the leaves also very different.

Pleiospermium (or at least *P. dubium*) differs, so far as known, from all its relatives among the small, soft-rinded, gummy-celled group of citrous fruits in having short and slender pulp vesicles arising from the inner wall of the ovary. In this respect it resembles the subgenus Rissoa[5] of the genus Atalantia, belonging to a different subtribe, but it differs from that and from the other true citrous fruits in having the cells of the fruits filled with an aromatic, sticky fluid. A thorough study of the anatomy and morphology of the fruits of all of these genera is urgently needed in order to classify them in natural groups.

Pleiospermium seems to be a primitive genus, showing analogies with many rather diverse groups. It even shows a certain analogy in its leaf characters with the Philippine Chaetospermum,[6] one of the hard-shelled citrous fruits belonging to another distinct subtribe.

Two closely related species of Pleiospermium are known, one from southern India and Ceylon, the other from Java.

KEY TO THE SPECIES

Leaflets usually 3, obtuse; ovary glabrous ..... 1. *P. alatum.*
Leaflets 1, 2, or 3, acute or acuminate; ovary pubescent.. 2. *P. dubium*

1. **Pleiospermium alatum** (Wight & Arn.) Swingle

Limonia alata Herb. Madr. Wall. Cat. no. 6363. 1832 (nom. nud.).
Limonia alata Herb. Madr. Wight Cat. no. 324. 1834 (nom. nud.).
Limonia alata Wight & Arn. Prodr., **1**: 92. 1834.

ILLUSTRATIONS: Wight, Ill. Ind. Bot., **1**: pl. 41 (1840); Beddome, Fl. Sylvat., Outlines Bot., pl. 8, fig. 3.

TYPE LOCALITY: "Foot of the Neelgherries," Madras Presidency, southern India.

[5] SWINGLE, WALTER T. *Atalantia*, in Bailey, Standard Cycl. Hort., **1**:426. 1914.

[6] SWINGLE, WALTER T. *Chaetospermum, a new genus of hard-shelled citrous fruits.* Journ. Wash. Acad. Sci., **3**: 99–102. 1913.

DISTRIBUTION: Southern India and Ceylon; common in the hot, drier parts.

The writer has seen an authentic flowering twig of this species collected by Wight under his number 324 and now in the Kew Herbarium; on the same sheet are two twigs from Wallich's set under his number 6363. There is also in Kew Herbarium a sheet of three twigs with full grown fruits, collected by Wight (No. 370) at Palagantcherry in 1850. In the Berlin Herbarium there is a sheet of material from Wight's Herbarium distributed by Kew in 1866–7 under No. 370, Peninsula Indiae orientalis, which has 7 twigs, 3 of them in flower.

This species is called *Tumpat-kurundu* in the Singhalese language of Ceylon.

2. **Pleiospermium dubium** (Blume) Swingle.

? Limonia diphylla Houttuyn, Natuurl. Hist., II. **2:** 440, pl. 9, fig. 2. 1774; [Christman] Linné Pflanzensystem nach. . . . Houttuynisch. Werks Übers., **1:** 615, pl. 9, fig. 2. 1777.

Limonia? dubia Blume, Bijdr. Fl. Ned. Ind., **1:** 133. 1825.

Paramignia Blumei Hasskarl, Tijdr. Nat. Gesch., **10:** 137–138. 1843.

Paramignya Blumei Hasskarl, Cat. Pl. Hort. Bogor., 216. 1844.

TYPE LOCALITY: "In collibus calcareis prope Kuripan, Provinciae Buitenzorg," Java.

DISTRIBUTION: Western Java.

Hasskarl in 1843 transferred this plant to the genus Paramignya, at the same time changing the specific name to *Blumei*. Hochreutiner in *Plantae Bogorienses Exsiccatae*, under No. 111, *Limonia dubia* Blume, says that the plant growing in the Buitenzorg Garden is undoubtedly the original of Hasskarl and probably the same as that seen by Blume, though the absence of Blume's type makes it difficult to be certain.[7]

Fortunately there is in the herbarium of the Muséum d'Histoire Naturelle at Paris an authentic specimen of this species from Blume. The original label reads "*Limonia dubia* M. Blume 1836." This specimen consists of a spineless twig of three seasons' growth with 19 nodes bearing 1-, 2-, or 3-foliolate leaves, very like the specimens distributed by Hochreutiner from the type plant of *Paramignya Blumei* Hasskarl.[8]

[7] "Cette plante est sans aucun doute l'original de Hasskarl qui a complété très exactement la diagnose de Blume. Quant à affirmer que c'est bien là l'espèce que Blume avait en vue, cela est plus difficile en l'absence d'un type de cet auteur; cependant c'est probable."—HOCHREUTINER, B. P. G., loc. cit.

[8] Probably Blume planted in the Buitenzorg Botanic Garden the tree from which the branch now in the Paris Herbarium was cut and upon which later on, Hasskarl based his description of *Paramignya Blumei*. In this event all the specimens cut from this tree (III. G. 64, in the Buitenzorg records) are merotypes of Hasskarl's species.

It is possible that this plant is identical with the enigmatic *Limonia diphylla* published in 1774 by Houttuyn, who received a twig collected by Richter at Batavia, where it is said to produce fruits resembling limes ("regte Limmetjes of Lemisjes"), the size of a pigeon's egg, on spiny twigs. The leaves are said to be paired on the same petiole. Houttuyn's plate shows a twig with 3 binate leaves with obtuse leaflets, one small unifoliolate leaf, and a small terminal flower with 4 petals and 8 stamens. The figure seems to be diagrammatic and was probably drawn from poor material. The plant is said to be called *Crandang* by the Javanese.

It may be that Houttuyn's species was founded in part on Richter's account of a true lime, *Citrus aurantifolia* (Christm.) Swing., and in part on a twig which he brought to Holland from Batavia, possibly from some very different plant, such as a Bauhinia. It seems impossible to decide the matter unless Houttuyn's type can be found.

Pleiospermium dubium seems to be rather close to *P. alata*, but has the leaflets acute, instead of obtuse, and many leaves with only 1 or 2 leaflets instead of 3, as is common in *P. alata;* also it has the ovaries pubescent instead of smooth, as figured in the Indian species. It is said to be a small tree 3.5–4 meters high, with a twisted trunk branching at 1.5 meters and suckers from the base. It is called *Kidjeroekan* in Java.

In its foliar characters this is one of the most polymorphic species among all the relatives of Citrus. The leaves are simple or 2- or 3-foliolate, sometimes all three forms occurring on the same branch. The petioles are sometimes very short and sometimes rather long, sometimes plainly winged, often nearly wingless. The spines are sometimes single, sometimes paired, and often entirely wanting. It is undoubtedly one of the most primitive of all the citrous plants, showing as it does striking analogies with plants belonging to at least three distinct subtribes.

The fruits of this species show small and slender pulp vesicles arising from the inner ovary wall 2 to 3 or even 4 mm. long. It is not known whether *P. alatum* also has such rudimentary pulp vesicles. Both species have fruits filled with dark-colored, strong-smelling, mucilaginous gum.

POSSIBLE UTILIZATION OF PLEIOSPERMIUM

From the fact that *Pleiospermium alatum* grows abundantly in the dryer parts of Ceylon it would be desirable to test it as

a stock on which to graft Citrus for culture on the dryer types of soil. The other species, *Pleiospermium dubium*, was discovered growing on limestone hills in western Java and may perhaps be able to endure more lime than the stocks now commonly used in citrous culture. Certainly both species of Pleiospermium should be introduced into this country and tested as stocks. In view of its primitive and polymorphic nature it is possible that *P. dubium* may hybridize with Atalantia or with some other true citrous fruit.

PHYSIOLOGY.—*Studies on the mineral elements in animal nutrition.*[1] E. B. FORBES, Ohio Agricultural Experiment Station.

As agricultural scientists, our interest in the mineral elements lies in that larger intermediary metabolism between the soil and the sea which begins with the weathering of the rocks, includes the whole of plant and animal metabolism, and ends with the formation of new rocks. Throughout this vast sweep of chemical change the mineral elements occupy a unique and dominating position, entering in essential ways into every process and exerting an influence in metabolism entirely out of proportion to the amounts in which they are involved.

In a large and general way life may be regarded as a coordinated system of responses to electrical stimulation. The ions, and especially the inorganic ions, are the bearers of this electricity, and it is because of this fact that they are able to play a leading rôle in the direction of the whole process of metabolism. Gustav Mann says, "So-called pure ash-free proteids are chemically inert and in the true sense of the word, dead bodies. What puts life into them is the presence of electrolytes."

This, then, is the basis of our interest. More specifically, this subject concerns us because the mineral elements of soil fertility—of plant nutrition—supply the mineral nutrients of animals. All of those conditions of growth of plants, as to

[1] A lecture delivered before the Washington Academy of Sciences, April 21, 1916.

soil fertility, heat, light, and moisture, which affect their mineral content affect the food value of these products for animals. Similarly all of those processes of treatment of foods, as to conditions of harvesting, storage, manufacture, preservation, and preparation which affect their mineral content have a bearing on the nutrition of animals. Further, the almost unlimited freedom of choice of foods afforded by our markets and our prosperity, a freedom which may profoundly affect the mineral content of the diet, furnishes a basis of interest and an obligation to understand. Finally, the mineral requirements of men and animals in their various conditions and stages of life, growth, health, and activity differ greatly in such ways as to demand our attention, since the whole range of success and profit in practical animal nutrition lies close, and ever closer, to maximum possibilities.

As this subject relates to stock feeding, we find that modern tendencies give it a special importance that it had not in times past. The forced feeding of our early-maturing meat animals and the selective improvement of our poultry and our dairy cows for greater productive capacity call for a higher percentage of mineral nutrients in foodstuffs than was necessary in the old days of less intense production. The requirement of mineral nutrients for mere maintenance is slight in amount, compared with the requirement for the production of flesh, eggs, and milk; hence, the more efficient the producer, the higher must be the ash content of the food.

My own investigations in this field consist of studies of the chemistry of foods, and metabolism experiments with swine and milch cows. I shall review briefly some of the conclusions from this program of work.

Our studies on foods comprise a series of complete ash analyses, with computations of the elements to normal solutions, these data being considered in relation to the balance of base and acid in the organism; also a study of the mineral nutrients of bluegrass, and factors which affect the quantities present; and a study of the iodine content of foods in relation to the prevalence of goiter.

It is an established fact of animal physiology that the vital processes require the maintenance of a state of approximate neutrality in the blood and lymph. Henderson has done much to show how this balance of acid and base is maintained by self-adjusting chemical and excretory equilibria. The mineral elements of the food contribute to one side or the other of this base and acid balance; and the extent and nature of this contribution are matters of importance in relation to acid intoxication, even though this condition is not commonly caused by the food. Our extensive series of ash analyses show that cereals, meats, and eggs have acid ash, while fruits, roughages, vegetables, milk, and most legumes have alkaline ash. While healthy animals have means of neutralizing all ordinary excesses of acid in the food it is safest that the bases should predominate, since we do not know that the neutralization of acids is always accomplished without expense, and since in any such physiological state as causes acid intoxication (and there are many such) an excess of mineral acid to mineral base in the food is undoubtedly a matter of positive disadvantage.

Acid intoxication is met with most commonly in the feeding of infants and older children suffering from fever, undernourishment, or indigestion especially involving the fats of the food. In these cases the use of whey in the diet furnishes mineral nutrients of value; and the administration of sodium citrate (1 to 2 grains per ounce of milk) is also a beneficial practise in that it furnishes a readily oxidizable alkali salt. The presence of this citrate is also favorable to the digestion of casein. Many a so-called idiosyncrasy against milk protein has disappeared under the influence of sodium citrate and a low-fat diet.

Our study of the mineral nutrients of bluegrass touches a subject of deep significance. Through its habit of growth grass is the great conserving factor in agriculture. As the basic requirement of livestock breeding it makes for all the benefits of this system of farming, especially the maintenance of the fertility of the land and the maintenance upon the land of the presence of the family of the owner. The permanent prosperity of an agricultural community is assured by the excellence of its grass lands.

Now we have shown that the mineral nutrients of bluegrass vary more than 100 per cent in accord with the fertility of the soil. The skeletons of growing animals respond readily to the mineral nutrients of the food. There is no definite upper limit of phosphate deposit in the bones. The quality of the grass must affect the quality of the bones; and strength and soundness of bone favor long-sustained efficiency. Probably the greatest strain to which the bones of animals are subjected is in the service of our large, early-maturing horses on hard-surfaced roads and pavements. The most famous horse-breeding center of the United States is a region of limestone soils and luxuriant bluegrass which our analyses show to be unusually rich in bone food. We have always bowed while the Kentuckian asserts that his state produces the most beautiful women and the finest horses in the world, and now we know that in so far as these claims depend upon a superior quality of bluegrass they rest on a substantial basis of fact.

It is also true that in many localities in this country, on impoverished soils, we find horses and cattle suffering from malnutrition of the bones. This ailment is most common during periods of rapid growth or milk production, especially during and immediately after seasons of drouth and restricted food supply. This condition responds readily to treatment with calcium phosphate.

Among the several mineral elements present in foods in minute quantities especial interest attaches to iodine, because of its importance in metabolism. The only tissue in the bodies of vertebrate animals which contains iodine in apparently essential relations is the thyroid gland. The iodine content of the thyroid may be increased by the administration of iodine; one of the active principles of the thyroid is its iodine-containing constituent; and goiter in certain stages responds favorably to iodine treatment. Further, there is a marked and continuous local prevalence of goiter in many regions. These facts furnish sufficient basis for our interest in the iodine content of foods.

In our study iodine was estimated in 927 samples of animal and vegetable products. These products were in part common

foods from the market; a large number were from the fertilizer plots of the experiment stations of the country; others were from regions of interest because of the extreme prevalence or rarity of goiter; still others were products from an extensive metabolism experiment with milch cows. The method of estimation used was accurate to three-millionths of a gram of iodine.

About one food sample in five contained iodine. The amounts present were usually too small for expression otherwise than as traces. In 18 samples each of cow's milk, urine, and feces no iodine was found. Iodine was found in considerable quantity only in agar and in Irish moss (from which *blanc mange* is made). No other seaweeds were examined. No iodine was found in 16 samples of table salt or in any one of seven kinds of nuts. It is very rarely present in spices and condiments.

Among the animal products the only one containing iodine in more than traces was hair and hoof, from swine, a sample prepared in the course of a complete chemical accounting for the bodies of some experimental subjects. Traces were found in butter, in eggs, and in several kinds (but by no means in all samples examined) of meat, fish, and crustacea (shrimp and lobster).

Among the cereals iodine was found as an uncommon constituent, usually in traces only. None of the fruits contained more than the smallest recognizable traces of iodine, and very few contained even so much.

Among the garden vegetables and root crops beets rather commonly contained traces of iodine (9 samples out of 25), and in one case a larger amount. Two out of three samples of cucumber contained iodine; also one out of three samples of celery. Iodine was found in single samples of endive, kohl rabi, and lettuce. Among onions five samples out of 15 contained iodine, and in parsnips two out of six. Six samples of potatoes out of 21 contained iodine; it was also found in spinach and in rhubarb. We found iodine in one sample of turnips out of 11, but none in tomatoes, pumpkin, and squash.

Of the hays, silage, and forage crops about one sample in four contained iodine. Among leguminous seeds iodine was

found in 11 samples out of 32, more commonly among beans, peas, and cowpeas than among soy beans.

The manufactured foods, and milling and manufactory by-products contained iodine in 13 samples out of 25; of those containing iodine 10 were made from cereals. The offal portions of the grains are apparently richer in iodine than the more starchy parts.

The more important sources of iodine in the human dietary, then, are the garden vegetables, though some is also found in the cereal foods and in several foods of animal origin, mostly of the sorts less commonly used.

Among the foods used by livestock the more important sources of iodine are the hay, silage, and forage crops, and also the milling and manufactory by-products, comparatively little being found in the natural grain foods.

No consistent or orderly geographic distribution of iodine in foods was revealed; nor were there noticeable effects of the type of soil or method of fertilization on the iodine content of foods. We found nothing characteristic in the iodine content of foods from regions where goiter was especially prevalent. The iodine content of samples of the same crop from different plots of the same field sometimes varied greatly.

The general conclusion from this study was that iodine is a comparatively unusual food constituent and that its presence is commonly accidental in the sense of standing in no essential relation to the growth of the food products. Variations in the iodine content of foods were not successfully correlated with any associated conditions.

It is possible that the total iodine requirement of the organism is gleaned from foods containing so little of this element that its presence would escape detection by our best methods of estimation. It is also possible that the iodine content of the drinking water is of greater importance in relation to the cause of goiter than is the iodine content of the foods.

The general effect of this study is to direct us elsewhere, especially toward the metabolism of the organism, in our search for the cause of goiter.

We shall now consider the results of mineral metabolism studies with swine. This subject is of especial importance in this connection because no other animals are so grievously sinned against in the provision of their mineral requirements. Several factors unite in bringing about this state of affairs. Among these are the extreme rapidity of growth of improved hogs, the great weight of fat carried, the early age at which reproduction and lactation occur, the custom of rearing hogs in comparatively close confinement, and the feeding of too little else than corn. This combination of conditions often results in the crippling of hogs during shipment to market, the breaking down of sows while suckling pigs, and a general abbreviation of the period of usefulness of breeding stock.

Our studies with swine have been on the specific effects of corn and of supplements to corn, and a comparison of the nutritive values of several pure compounds of phosphorus, these studies having been conducted by feeding, slaughter, and carcass analysis experiments, and by metabolism investigations.

In these feeding and carcass analysis experiments the specific effects of corn as an only food for growing swine were shown to be, in general, a retarded development of proteid and bony tissues and an over-development of fatty tissue. This results in the production of fine-boned, poorly muscled, undersized, and over-fat animals, which reach their limit of growth prematurely and which are characterized by less than normal breeding capacity. Impaired fecundity seems to result from discouragement of proteid increase generally and from the lessened circulation of blood in the female reproductive organs, this last being caused by pressure of the excessive amounts of internal fat which accumulate about these parts. With hogs fed on corn alone, the bones, muscles, liver, kidneys, lungs, heart, and spleen all compose an abnormally small proportion of the increase in weight, and fat composes an abnormally large part of the increase. The bones are lacking both in density, as indicated by ash content, and in breaking strength.

Many of the specific effects of corn as an only food for growing animals are due to its insufficient content of protein and to

the incomplete character of its largest protein constituent, zein. The only effects which can safely be attributed to the mineral constituents of corn are those affecting the skeleton.

In one experiment corn alone was compared with corn supplemented by soy beans, linseed oilmeal, wheat middlings, tankage, and skim milk. The rations of corn alone and of corn and soy beans produced the least bone. The rations of corn supplemented by tankage and skim milk produced the most bone. Rations of cereals or other seeds will not produce normal growth of bone in swine. These facts depend directly on the content of these foods in the chemical elements which compose bone.

The proportion of calcium, magnesium, and phosphorus in the bones tends strongly to remain constant, but may be modified to a certain extent by the limitations of the food. The amounts of these elements in the bone, however, are susceptible of much greater modification through the composition of the food. Bone meal, when added to a ration which is low in calcium and phosphorus, will greatly increase the ash and strength of the bones. The change in external dimensions is slight, but increase in the density and thickness of the walls of the bones may proceed indefinitely. The readiness with which minerals may be deposited in the bones, the lack of a definite upper limit of such deposit, and the readiness with which these minerals may be withdrawn constitute the skeleton a true store of mineral nutriment.

We have not been able by any method of feeding, in confinement, to produce bones as strong as are the bones of pigs raised on pasture. It seems quite possible that exercise, as well as food, has its effect to strengthen the bones through inducing an added avidity of the osteogenic cells for bone salts.

In a metabolism investigation with swine five pigs, all from the same litter, were taken through eight 10-day collection periods separated by 7-day intervals. The feeds, as in the experiment last mentioned, were corn alone, compared with corn supplemented by soy beans, linseed oilmeal, wheat middlings, tankage, and skim milk; also one ration was composed of rice polish and wheat bran. The pigs grew normally, and stored

nitrogen and sulphur liberally in each period, though, naturally, less of these elements was stored from the ration of corn alone than from rations containing more protein.

Potassium was stored in all periods except one; strange to say, the ration composed of rice polish and wheat bran was the one in which this element was supplied in the greatest amount. Animals have no means of storage of large amounts of potassium salts. The large excretion of potassium on this maximum intake may be considered as a protective measure. In this case the negative balance did not signify insufficiency.

Sodium and chlorine balances were much affected by the water drunk. The intake of these elements would have been insufficient had not the amounts present in the foods been supplemented by the use of salt. Those individuals which drank the least water retained the most sodium and chlorine.

The more significant results of this experiment have to do with calcium, magnesium, and phosphorus. These elements are closely associated in metabolism. In the two rations where the corn was supplemented by skim milk and by tankage (containing a considerable amount of bone scrap) the calcium retention was 9 to 10 times as great as in any of the rations composed of grains and other seeds and seed products. On rations of corn alone, of corn and soy beans, and of rice polish and wheat bran the calcium balances were negative; that is, more calcium was given off in excreta than was received in the food. This result emphasizes the fact that the cereals are very poor bone-foods. The negative calcium balances from the ration of corn and soy beans call attention to the fact that the phenomenally high calcium content of legumes is true of the plants as a whole and not of the seeds. This emphasizes the value of leguminous roughage as bone-food.

In these rations the retention of calcium was closely related to the intake of the same, and not appreciably affected by the excess of mineral acid. Physiologically, calcium and magnesium are balanced opposites. An excess of magnesium in the blood causes a counter-active liberation of calcium; but the proportion of these elements in the blood does not follow closely their

proportions in the food, and we did not find the calcium retention to be limited by an excess of magnesium in the food except perhaps in one ration, composed of rice polish and wheat bran and containing 12 times as much magnesium as calcium. In this case the great excess of magnesium seems to have been unfavorable to calcium retention. This proportion seems not to be a matter of practical importance in ordinary rations.

The phosphorus balances in these rations were always positive, but the retention was much below normal on the ration of corn alone. The more important reason for this deficient storage of phosphorus from corn was the lack of calcium, since calcium was more deficient than phosphorus, and since neither can be stored in large quantity except as they are combined in the calcium phosphate of the bones.

There were large excesses of inorganic acid elements in these rations. They were neutralized by ammonia. We observed no evidence of acid intoxication. We do not have knowledge of any such prevalence of acid intoxication in domestic animals as that with which we are familiar in human beings.

The urinary ammonia excretion was found to vary in the same order with the excess acid of the ration, providing that the protein remained about the same in amount; but any considerable increase in the food protein also increased the urinary ammonia.

Another series of experiments with swine dealt with phosphorus metabolism. Considering the phosphorus compounds of plants and animals the most obvious distinction among the various groups is that in certain of these the phosphorus is organically combined, as part of the living tissue, while in others it is present as simple salts of the mineral bases, either in solution, or deposited in supporting structures (in animals), or as crystals or incrustations (in plants). Our object was to learn whether organic and inorganic phosphorus in the food could serve equally well all of the purposes for which the animal needs phosphorus.

Our practical interest in the problem is due largely to the relative availability of organic and inorganic phosphorus. Inor-

ganic phosphorus may be had in unlimited quantities as prepared from old bones and rock phosphate, and the inorganic phosphorus content of foods may be greatly increased by the fertilization of the soils upon which they are grown. Organic phosphorus we get from such expensive foods as milk, eggs, and beef, and from cereals. The organic phosphorus content of foods is not susceptible of important modification by treatment of the soil.

In this study we included orthophosphates because of their cheapness and availability, hypophosphites because they are so much used in human medicine, phytin as an especially abundant phosphorus storage compound of vegetable foods, glycerophosphates because of their relation to lecithin, a universal cell constituent, and nucleic acid because it is found in the nuclei of all cells.

These compounds in the pure form were added to a low-phosphorus basal ration in amounts contributing equal quantities of phosphorus. The subjects were growing pigs. Results were obtained by the method of the metabolism experiment and by the analysis of the carcasses of the animals.

It would seem, at first glance, that this problem should readily yield to careful experimental investigation, but intimate acquaintance has shown it to be extremely complicated and difficult. Many investigators have studied it, and the problem has been finally answered many times but in many different ways. If this problem is settled, in the end, as many such subjects of controversy have been, most of those who have studied it will be at first surprised, then chagrined, and then gratified that so much of truth was found on both sides of the discussion. Recent evidence has been mostly with those who believe that inorganic phosphorus can serve all of the purposes for which animals need phosphorus, but there is still much uncontroverted evidence that there are differences in the metabolism of some organic and inorganic phosphoric compounds which imply at least a greater usefulness of some organic compounds for some purposes with some animals.

In our work orthophosphates, gylcerophosphates, hypophosphites and yeast nucleic acid, when added in the pure form to rations which are low in phosphorus but capable of maintaining phosphorus equilibrium, were all to some extent absorbed and retained.

Prominent differences were observed in the tolerance of the pigs for these pure phosphorus compounds. The limit of tolerance for glycerophosphates was not reached in any of our tests, but the other compounds were not so well taken. These drugs, when taken into the alimentary tract in quantity, in readily soluble condition, produced marked specific therapeutic effects which were, at least to a large extent, unrelated to fundamental nutritive values, and were likewise different from the effects of the same compounds as occurring in their natural physical and chemical relationships in foods. It is, therefore, impossible to state, from investigations of this sort, on pure compounds, what may be their nutritive values in common foods.

That the particular organic compounds used in this investigation (nucleic acid, phytin, and glycerophosphates) have nutritive values, to growing swine, superior to simple inorganic phosphates was not shown. No fundamental differences in the methods of usefulness of the phosphorus compounds studied were established, though, under our experimental conditions, they differed greatly in the extent of their usefulness; for instance, glycerophosphates were acceptable and useful in large quantities, the limit of which was not reached in our work; orthophosphates were distinctly less acceptable; phytin and nucleic acid were tolerated in still smaller amounts; while hypophosphites were the least acceptable of all. Still, so far as our results indicate, these compounds were all useful in the same way.

No basis was discovered for a differentiation between the nutritive values of organic and inorganic phosphorus compounds generally. It should be borne in mind, however, that no representatives of the two classes, phosphoproteins and lecithins, were included in this investigation, and results obtained under conditions of such rigid experimental control may not accurately represent the facts under optimum, normal conditions of life.

These results are not considered to controvert evidence as to specific therapeutic effects of these phosphorus compounds in relations other than those considered in this study.

Even granting the debated superior nutritive value of organic or inorganic compounds of phosphorus, however, it is undoubtedly a fact that the organic phosphorus content of the animal body is a very small part of the total phosphorus, and as certainly true that a very much larger proportion of organic to inorganic phosphorus prevails in the diet of all omnivora and herbivora than in the bodies of these animals; and as for carnivora, the consumption of flesh and bones together would give them approximately the same proportion of organic to inorganic phosphorus in the diet as in their own bodies. It would seem, therefore, that for purposes of growth, the usual diet of animals must contain a sufficiently large proportion of organic to inorganic phosphorus. In this relation, then, the important consideration is simply one of the total phosphorus of the ration, and any such supplemental phosphorus as is to be added to the diet of the healthy, growing animal may be added as inorganic phosphate.

The amount of phosphorus which an animal will tolerate, when added to the ration in readily soluble form, is definitely limited at an amount much less than will be acceptable in its natural relationships in foods.

It seems unlikely that, with grown or growing animals, any ration composed from natural foods, and supplying the nitrogen requirement, will fail to furnish enough total phosphorus to maintain phosphorus equilibrium. That many such rations are lacking in the amount of phosphorus essential to maximum retention and growth, however, is as certainly true.

The results of our experiments indicate that the possibility of influencing, to a practical extent, the relative development of tissues and organs of livestock by the addition of isolated compounds of phosphorus to the ration is probably limited to the density and strength of the bones; but this is not saying that we may not be able by the use of these same compounds profoundly to influence physiological functions.

Throughout these studies of the influence of foods upon the nutrition of swine numerous effects of the mineral constituents of the rations on minor details of qualitative composition of the tissues have been noted, but the importance of such effects, as related to the functions of the parts, has not been demonstrated.

Our latest study in mineral metabolism was with cows. The milch cow greatly excels any of the other farm quadrupeds in the rapidity and efficiency with which she produces proteid and mineral nutriment. This unrivaled productive capacity calls for as unusual supplies of the kinds of nutriment involved. So far as protein is concerned this requirement is amply recognized; but, with almost no evidence on the subject, we have assumed that the cow's mineral requirements are fully met without any attention being given to the matter. Our results show this assumption to be unwarranted and untrue.

Six cows were used in this study, in two groups of three each. Each cow was taken through three experimental periods, usually of 19 or 20 days' duration, separated by 10-day intervals. The excreta were caught by attendants sitting behind the cows. Complete ash analyses, as well as ordinary proximate analyses, were made on foods, milk, urine, and feces.

We found that liberal milk production, on common practical winter rations fed in quantities sufficient to maintain the live-weight and to cause regular and extensive nitrogen and sulphur storage, caused large and consistent losses of calcium, magnesium, and phosphorus from the skeleton. These losses occurred in spite of liberal supplies of these nutrients in the food. The very limited response of the cows to large increase in the intake of these elements suggests that the selective improvement of the milch cow, for milk production, has outrun her capacity to digest mineral nutrients. A further study is in progress in which we hope to learn whether under any circumstances it is possible to protect the cow from loss of minerals during heavy milk production.

An extensive metabolism of silicon was demonstrated; and an excess of inorganic acids over inorganic bases in the ration, due

largely to the silicon of timothy hay, caused an acid reaction and an increase in the ammonia of the urine.

From this study it appears that a failure to maintain mineral equilibrium must be so common among cows of the more profitable sort that it may be considered a normal condition during the time of larger production, at least if this occurs during the winter, that is, while the cows are off from pasture.

A common failure of cows to maintain exceptionally high production during consecutive periods of lactation may be due to mineral depletion, as may also be a frequent failure of cows to breed after having been subjected to a period of forced production, as in the establishment of records.

Since extensive milk production is sustained, in part, by drafts upon the mineral reserves of the body; since this process can not continue indefinitely; and since there is in cows a gradual shrinkage and final cessation of milk production coincident with this depletion of nutrient reserves, it is believable that this mineral exhaustion may be among those factors which cause the gradual shrinkage of milk, and that by preventing, as largely as possible, these losses from the body we may be able to lessen the shrinkage and to extend the duration of the production of milk.

The results of this study indicate that especial attention should be given to the calcium, magnesium and phosphorus contents of the rations of heavily-producing cows, in order that the loss of these elements from the skeleton may be kept as low as possible; and a liberal supply of foods rich in these elements should be allowed after a cow has ceased to produce heavily, during the latter part of the period of lactation, in order to refund previous overdrafts before the birth of the next calf.

It is impossible, of course, to draw any one conclusion which will express the full significance of so varied a program as that which I have reviewed with you, but to me the results of these studies have appealed, more than in any other way, as related to the service of lime and legumes in agriculture.

Calcium is very much the most abundant mineral in the animal body. Physiologically it is the great mineral stabilizer.

Practically, it is much more frequently lacking in the food of men and animals than is any other mineral nutrient. Lime as applied to the soil liberates organic nutriment and enriches the grass in calcium. It stimulates the growth of grass and makes it a better food for animals. In a sense, "All flesh is grass." Lime also maintains in the soil conditions favorable for the growth of legumes. The legumes draw heavily upon this lime and furnish it to animals in quantities not approached by any other food plants. Through the activity of the bacteria which cause their root-nodules they are enabled not only to store nitrogen in abundance but also to feed the grasses with which they are associated. Thus the lime in the soil favors the growth of legumes. Lime and legumes favor the growth of grass. Grass and legumes control the breeding of livestock. Grass, legumes, and livestock control the destinies of nations.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. Each of the scientific bureaus in Washington has a representative authorized to forward such material to this journal and abstracts of official publications should be transmitted through the representative of the bureau in which they originate. The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*Distribution of energy in the visible spectrum of an acetylene flame.* W. W. COBLENTZ and W. B. EMERSON. Bureau of Standards Scientific Paper No. 279 (Bull. Bur. Stds., **13**: 355–364). 1916.

Data on the distribution of energy in the visible spectrum of a standard source of light are frequently needed in connection with investigations in physiology, in psychology, and in physics; especially in photoelectric work, in photography, and in the photometry of faint light sources. Frequent requests for such data have come to this Bureau. The acetylene flame appears to be a promising source of light having a high intensity and a white color. The present paper gives data on the distribution of energy in the visible spectrum of a cylindrical acetylene flame, operated under specified conditions.

In the region of the spectrum extending from the yellow to the violet the spectral energy distribution of all the flames examined appears to be the same, within the limits of observation. On the other hand, in the region of the spectrum extending from the red toward the long wave lengths the emissivity is greatly affected by a variation in thickness of the radiating layer of incandescent particles in the flame. Hence, in and beyond the red part of the spectrum the data apply only to cylindrical flames which are operated under specified conditions.

W. W. C.

PHOTOMETRY.—*An interlaboratory photometric comparison of glass screens and of tungsten lamps, involving color differences.* G. W. MIDDLEKAUFF and J. F. SKOGLAND. Bureau of Standards Scientific Paper No. 277 (Bull. Bur. Stds. **13**: 287–307). 1916.

In 1911 the Bureau of Standards and the National Physical Laboratory of England, in coöperation, established groups of 1.5 wpc tung-

sten standards, using Lummer-Brodhun contrast photometers in stepping from corresponding groups of 4 wpc carbon standards. Although the agreement between the two laboratories was very satisfactory and subsequent measurements of the new standards at the Bureau checked the original values, it was realized, in view of the small number of observers in each laboratory, that if other groups of observers had made the measurements or if some other photometric method had been used the results might have been different.

Therefore, in order to obtain information as to the agreement which might be reasonably expected among different groups of experienced observers working by the same and by different methods, the Bureau invited the Nela Research Laboratory, the Electrical Testing Laboratories, and the Physical Laboratory of the United Gas Improvement Company to cooperate in an intercomparison of photometric measurements of blue glass screens and tungsten lamps involving color differences such as were encountered in the establishment of the new standards. The first two laboratories, like the Bureau, used Lummer-Brodhun contrast photometers, while the third used a special flicker photometer, and in no laboratory were the screens and lamps measured at the same time.

The results of the intercomparison show that each observer, regardless of the kind of photometer used, maintained a fairly definite criterion with respect to the mean of his laboratory, and that each laboratory likewise consistently maintained its relation to the mean of all, as judged from the measurements on the screens and those made on the lamps some months afterward.

Considering the difficulties involved in the measurements, the different characteristics of observers, and the wide difference in illumination employed, the agreement among the laboratories was remarkably good. It is true, however, that although the differences are small they are not negligible in precision photometry. It is evident, therefore, that measurements to establish standards involving color difference should be left as much as possible to the standardizing laboratory, where the observers must be carefully selected and a considerable number employed, and the kinds of instruments and other conditions definitely fixed.

An examination of the Bureau's observers who took part in this intercomparison and who were included in a group of 114 observers tested at the Bureau by Crittenden and Richtmyer, using a special

flicker photometer, shows that their mean characteristic is very approximately the same as that of the average of the 114.

Furthermore, the flicker values found in this intercomparison and also by Crittenden and Richtmyer for the tungsten lamps at 1.5 wpc are in agreement with the Bureau's values. Hence it is concluded that the values which were originally assigned to the new 1.5 wpc tungsten standards as a result of the intercomparison with the National Physical Laboratory can be considered as average eye values.

G. W. M.

GEOLOGY.—*Economic geology of the North Laramie Mountains, Converse and Albany Counties, Wyoming.* ARTHUR C. SPENCER. U. S. Geological Survey Bulletin No. 626, pp. 46–81, with 2 plates and 4 figures.

This report includes a description of the broader geological features of the North Laramie Mountains and detailed notes on localities where prospecting work has been done in the search for copper ores. A colored geologic map of the general region, contributed by N. H. Darton, shows a central belt of pre-Cambrian rocks, flanked by areas of stratified rocks ranging in age from Carboniferous to late Cretaceous. With one exception the metalliferous deposits examined occur in the old crystalline rocks, which comprise granite, serpentine, and schists of various kinds.

In general the copper deposits of the region are not promising, though it is possible that in a few places small deposits will be profitably worked. Deposits of chromite and of asbestos occurring in the western part of the region appear not to be of economic importance.

A. C. S.

GEOLOGY.—*Geology and underground water of Luna County, New Mexico.* N. H. DARTON. U. S. Geological Survey Bulletin No. 618. Pp. 188, colored map, 12 other plates, 15 text figures. 1916.

A large part of Luna County consists of a desert plain underlain by sand, gravel, and clay of Quaternary age. Rising from this plain are narrow rocky ridges which contain a thick succession of sedimentary and igneous formations resting on pre-Cambrian granite, the whole considerably flexed and faulted. The sedimentary rocks include formations of Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Triassic (?), Cretaceous, and Tertiary age but only a portion of each period is represented. Most of the formations present features similar to those in

other parts of southern New Mexico and western Texas but some of them are local or present peculiarities. The Tertiary rocks consist of thick accumulations of agglomerate, tuff, and ash and thin sheets of various kinds of lava.

The principal mineral resource is underground water, which occurs in large quantities in the deposits underlying the plain, and is pumped for irrigation. It is supplied by percolation from Mimbres River and by local rains. Tests of five wells by A. T. Schwennesen gave yields ranging from 122 to 603 gallons per minute, or from 14.5 to 88 gallons per minute for each foot of drawdown. O. E. M.

GEOLOGY AND ENGINEERING.—*Contributions to the hydrology of the United States, 1915.* NATHAN C. GROVER. U. S. Geological Survey Water-Supply Paper No. 375. Pp. 131, 9 plates, 31 text figures. 1916.

This volume includes the following papers:

Ground water for irrigation in the Sacramento Valley, California. KIRK BRYAN. Sacramento Valley, 150 miles long, 40 miles wide, and containing more than 3,000,000 acres of agricultural land, is remarkable for its great supply of ground water, the rapid recharge of this supply in the rainy season, and the large area in which the water table stands close to the surface. More than 80 per cent of the valley has a depth to water of less than 25 feet. In 1913, water was drawn from wells at 1664 pumping plants for the irrigation of 40,859 acres.

Ground water in Paradise Valley, Arizona. O. E. MEINZER and A. J. ELLIS. Paradise Valley affords an example of "stream escape," in contrast to "stream capture." Cave Creek, entering this valley from the side, formerly discharged through it, but built up its alluvial fan until it found an exit through a pass in the opposite mountain wall. It now crosses the valley and still furnishes most of its ground-water supply.

The relation of stream gaging to the science of hydraulics. C. H. PIERCE and R. W. DAVENPORT. This paper emphasizes the modernness of stream gaging as a science and coordinates it with the science of hydraulics and the still more comprehensive science of hydrology. The evolution of stream gaging to its present status has involved in a high degree that balancing of practice against abstract theory which has made hydraulics to so large an extent an empirical science. The importance of analytical studies and of utilizing the established facts of the science of hydraulics in the practice of stream gaging is illustrated by examples. Stream gaging, or, in a broad sense, hydrometry,

has a steadily expanding field in the collection of stream-flow data, both for statistical purposes and as a basis for the design of various kinds of hydraulic works, in drainage investigations, in the operation of irrigation systems in the arid regions, in the determination of hydraulic constants and coefficients, in the testing and operation of water-power plants, and in other directions.

Ground water in Big Smoky Valley, Nevada. O. E. MEINZER. Big Smoky Valley is a typical desert valley occupying a closed basin of 3250 square miles. Numerous beach ridges and embankments, 50 feet in maximum height, show that in the Pleistocene epoch this valley contained two lakes—Lake Toyabe, which covered 225 square miles, and Lake Tonopah, which covered 85 square miles. The alluvial slopes are broken by fault scarps, indicating maximum displacements of more than 100 feet. Nearly 50 small mountain streams discharge into the valley, 10 of which, according to measurements made in October, 1914, contribute 7000 acre-feet a year to the ground-water supply. Ground water is discharged into the atmosphere from two areas which together cover about 205 square miles. These areas were mapped on the basis of (1) soil moisture and position of the water table, (2) soluble salts at the surface and in the soil, and (3) native plants that feed on ground water.

A method of correcting river discharge for a changing stage. B. E. JONES. When a river is rising fast it has a greater velocity and a greater discharge than it has at the same height when its stage is constant. This is caused by the increase in slope due to the rising stage. Likewise, when it is falling fast it has a lower velocity and a lower discharge. A formula is obtained for comparing the discharge under changing stage conditions with that under constant stage conditions, as follows:

The change in slope is assumed equal to the change in stage per second divided by the distance the water travels per second. Then as the discharge varies as the square root of the slope, the relation of the discharge under constant stage conditions (Q_1) to the discharge under changing stage conditions (Q_2) would be

$$\frac{Q_1}{Q_2} = \frac{\sqrt{S_1}}{\sqrt{S_1 + \frac{\text{rate of change of stage}}{\text{velocity}}}}$$

S_1 in the equation is the surface slope under constant stage conditions.

As it is shown that a flood travels nearly at the rate of the surface velocity, the velocity used in the formula is the surface velocity which is obtained by dividing the mean velocity of the stream by 0.90.

If K stands for the change of stage per second, V for the mean velocity determined during the changing stage, and N for the coefficient for obtaining mean velocity from surface velocity, the formula may be written:

$$\frac{Q_1}{Q_2} = \frac{\sqrt{S_1}}{\sqrt{S_1 + \frac{NK}{V}}}$$

Tables and curves are given showing the results obtained by this method on streams varying in size from a canal carrying 50 second-feet up to the Ohio River carrying 365,000 second-feet.

Conditions requiring the use of automatic gages in obtaining records of stream flow. C. H. PIERCE. In 1913–14 the U. S. Geological Survey maintained 1741 gaging stations of which 325 were equipped with automatic gages. The conditions which require the use of automatic gages are (1) regulation of the stream by power developments; (2) operation of canals and ditches delivering water for irrigation; (3) fluctuations due to variation in run-off under natural conditions (*a*) caused by rain and (*b*) caused by melting ice and snow; (4) inaccessibility of gaging station or lack of reliable observer; (5) continuous record needed for legal purposes; and (6) human fallibility of most gage observers.

Ground water in Lasalle and McMullen counties, Texas. ALEXANDER DEUSSEN and R. B. DOLE. (Abstract in Journ. Wash. Acad. Sci., **6**: 224–225. 1916.) O. E. M., R. W. D., B. E. J.

GEOLOGY.—*Geology and water resources of Tularosa Basin, New Mexico.* O. E. MEINZER and R. F. HARE. U. S. Geological Survey Water-Supply Paper No. 343. Pp. 317, with maps, sections, and views. 1915.

Tularosa Basin is a closed drainage basin in south-central New Mexico covering about 6,000 square miles. Its central plain is in part underlain by sediments to depths of more than 1,000 feet and is bordered on both sides by fault scarps several thousand feet high. Features of special interest are: (1) basaltic lava sheets of two ages, both Quaternary, with three volcanic cones; (2) recent fault scarps and shore features;

(3) steep-walled alkali flats, covering 165 square miles, formed chiefly by wind erosion; (4) dunes of gypsum sand, covering 270 square miles, on the leeward side of the alkali flats; (5) sink holes developed in the gypseous valley fill; and (6) numerous large mounds produced by springs.

The basal granite is unconformably overlain by Carboniferous rocks which comprise Mississippian limestone at the bottom and limestone, red beds, gypsum, etc., of the Magdalena and Manzano groups at the top. Cretaceous deposits, chiefly of the Dakota to Montana groups, are well represented; also younger intrusive rocks. Coal was observed in Carboniferous as well as in the Cretaceous strata.

Water occurs in valley fill and in Cretaceous and Carboniferous rock. About 150 analyses were made. The waters differ widely in chemical character and concentration, several distinct types being recognized and correlated with different rock formations. Various relations of alkali in soil and of zones of vegetation to water supplies are described.

O. E. M.

MINERALOGY.—*Mineralogic Notes, Series 3.* WALDEMAR T. SCHALLER. U. S. Geological Survey Bulletin No. 610. Pp. 164, with 5 plates and 99 figures. 1916.

New minerals described are as follows:

Koechlinite, bismuth molybdate, $Bi_2O_3 \cdot MoO_3$, from Schneeberg, Germany, as small greenish-yellow rectangular plates, orthorhombic, simple and twinned.

Inyoite, from Inyo County, California, as white rhombic-shaped monoclinic crystals, $2CaO \cdot 3B_2O_3 \cdot 13H_2O$, largely altered to meyerhofferite.

Meyerhofferite, alteration of inyoite, colorless to white, prismatic, triclinic crystals, $2CaO \cdot 3B_2O_3 \cdot 7H_2O$.

Lucinite, dimorphous form of variscite, $Al_2O_3 \cdot P_2O_5 \cdot 4H_2O$, from Lucin, Utah. Very small green, octahedral-shaped orthorhombic crystals, directly associated with variscite.

Velardeñite, from Velardeña, Mexico, $2CaO \cdot Al_2O_3 \cdot SiO_2$, tetragonal, is an essential component of the "gehlenites" and enters into the composition of the "melilites."

Fremontite is the name proposed to replace the objectionable term natramblygonite for the hydrous sodium aluminum phosphate member of the amblygonite group, found in Colorado. Triclinic crystals of fremontite are described.

The other mineralogic papers treat of: (1) The crystallography of variscite, extending the crystal forms to 14 and noting several different habits. (2) The composition of schneebergite is definitely fixed as $2CaO \cdot Sb_2O_4$. The paragenesis of the schneebergite specimens from Schneeberg, Austrian Tyrol, is fully described and illustrated. (3) Romeite from Italy and from Brazil is analyzed and its composition determined as $5CaO \cdot 3Sb_2O_5$. The romeite from Brazil has been erroneously called atopite. (4) The natural antimonites and antimonates are listed. (5) The melilite group is studied and it is concluded that all melilites and gehlenites may be considered as isomorphous mixtures of the tetragonal minerals, velardeñite, $2CaO \cdot Al_2O_3 \cdot SiO_2$, sarcolite, $3CaO \cdot Al_2O_3 \cdot 3SiO_2$, and åkermanite, $4MgO \cdot 8CaO \cdot 9SiO_2$. (6) Thaumasite crystals, from West Paterson, N. J., are hexagonal, $c\{0001\}$, $m\{10\bar{1}0\}$, $p\{10\bar{1}1\}$, the c-axis being 1.09. (7) The water in tremolite is held to be essential and not "as dissolved water . . . . not chemically combined . . . . " Analyses suggest the formula, $8SiO_2 \cdot 5MgO \cdot 2CaO \cdot H_2O$; (8) Massive guanajuatite was identified from Salmon, Idaho, brilliant yellow to orange greenockite from Topaz, California, and well-crystallized jarosite from Bisbee, Arizona. (9) Gigantic crystals of spodumene (one 47 feet long) from the Etta mine, South Dakota, are described and illustrated. (10) Mariposite from California, and alurgite from Italy probably represent the same mineral species.

The bulletin also includes reprints of papers on cebollite, nephelite, bloedite, alunite, custerite, hodgkinsonite, pisanite, strengite, and a note on the calculation of a mineral formula. W. T. S.

BOTANY.—*The genus Espeletia.* PAUL C. STANDLEY. American Journal of Botany, **2**: 468–485, pl. 17, f. 1–6. 1915.

The genus Espeletia is a member of the family Asteraceae. Its representatives, natives of the high mountains of northeastern South America, are conspicuous among the composites because of the dense woolly covering of their leaves and inflorescence, and the peculiar habit of many of the species. The present study is based chiefly upon material from Venezuela received recently by the U. S. National Herbarium. Seventeen species are recognized, six of which are described as new. Six of the species previously described are represented in the National Herbarium by recent collections. P. C. S.

REFERENCES

Under this heading it is proposed to include, by author, title, and citation, references to all scientific papers published in or emanating from Washington. It is requested that authors cooperate with the editors by submitting titles promptly, following the style used below. These references are not intended to replace the more extended abstracts published elsewhere in this JOURNAL.

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Taboga, Cenopaschia, Pocopaschia, Stenopaschia, Glossopaschia, Difundella, Anypsipyla, Drescoma, Zamagiria, Cabima, Chorrera, Homalopalpia, Illatila, Anthopteryx, Bema, Relmis, Moerbes, Harnocha, Eurythmasis, Harnochina, Hypermescinia, Calamophleps, Comotia, Strymax, Microphycita, Microphestia, Micromescinia, Tinitinoa, Schenectadia, in the Pyralidae; together with 474 new species, 6 new subspecies and 5 new varieties, a few being extra-limital, coming from Brazil, British Guiana, Argentina and Ecuador. J. C. C.)

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TOWNSEND, C. H. T. *New muscoid flies, mainly Hystriciidae and Pyrrhosiinae from the Andean Montanya.* Insecutor Inscitiae Menstruus, **2**: 133–144 (continued). September, 1914. (Describes the new genera Trichosaundersia and Saundersiops, together with 12 new species and 2 new subspecies.—J. C. C.)

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